Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

LUMINARY Memo #123

To: Distribution
From: D. Eyles
Date: 18 November 1969
Subject: More About Delta-Guidance

Delta-guidance is running in AMELIA 11 (as also in some of the earlier revisions), which in other respects is just like LUMINARY 130, which was just released as 1C.

Here are the patches required:

location	old	new	symbolic	new
05, 2310	bad word	03641	ECADR	TTT/8
31, 2213	62325	63770	BZMF	31, 3770
31, 3770	unused	34755	CA	ZERO
31, 3771	unused	55610	TS	FWEIGHT
31, 3772	unused	55611	TS	FWEIGHT +1
31, 3773	unused	12325	TCF	THDUMP

On the next page is given the initialization which is different from that for LUMINARY 130. See Luminary Memo #115 for a description of the new parameters. Note that DELTTTAP has been eliminated since the initial TGO for P64 equals P63's final TGO. The values given are Allan Klumpp's latest. The only number not given is RPCRTIME which should be set equal to TENDBRAK to make the LR antenna reposition at high-gate.

TRAJECTORY DESIGN DEPENDENT DATA

VIGN	2D +1.69099951 E+ 1B-10	VIGG	+1.69099951 E+ 3	002471	00416	21726
RIGNX	2D -4.02612533 E+ 4B-24	RIGXG	-4.02612533 E+ 4	002473	77730	65653
RIGNZ	2D -4.36270484 E+ 5B-24	RIGZG	-4.36270484 E+ 5	002475	77125	76427
KIGNX/B4	2D -.038601937	KX	+6.17630999 E- 1	002477	76607	61356
KIGNY/B8	2DEC 0			002501	00000	00000
KIGNV/B4	2D -.156402587	KV	+4.10000000 E+ 2	002503	72775	57777
RBRTGX	2D +3.79762136 E+ 2B-24		+3.79762136 E+ 2	002402	00000	13674
RAPTGX	2D +2.93043502 E+ 1B-24		+2.93043502 E+ 1	002404	00000	00725
RBRTGZ	2D -4.52071878 E+ 4B-24		-4.52071878 E+ 4	002406	77723	73214
RAPTGZ	2D -9.39081728 E+ 0B-24		-9.39081728 E+ 0	002410	77777	77551
VBRTGX	2D +5.46925427 E- 1B-7		+5.46925427 E+ 1	002412	00106	00152
VAPTGX	2D +9.50627990 E- 3B-7		+9.50627990 E- 1	002414	00001	06740
VBRTGZ	2D -6.27549803 E+ 0B-7		-6.27549803 E+ 2	002416	76334	67436
VAPTGZ	2D -5.51227250 E- 3B-7		-5.51227250 E- 1	002420	77777	51327
ABRTGX	2D +5.87004660 E- 2		+1.14649347 E+ 0	002422	01701	27746
AAPTGX	2D +6.14681267 E- 3		+1.20054934 E- 1	002424	00144	26546
ABRTGZ	2D -2.62579450 E- 1		-5.12850488 E+ 0	002426	67461	74575
AAPTGZ	2D -3.34411788 E- 4		-6.53148024 E- 3	002430	77772	60527
JBRTGX	2D +1.38353801 E- 1		+6.18489691 E- 3	002432	04332	31172
JAPTGX	2D +7.66667726 E- 2		+3.42727181 E- 3	002434	02350	03360
JBRTGZ	2D -9.74846498 E- 2		-4.35790344 E- 3	002436	74702	71757
JAPTGZ	2D +2.61468828 E- 1		+1.16885674 E- 2	002440	10273	34760
SBRTGX	2D +1.38918454 E- 2		+1.89518398 E- 6	002442	00343	23250
SAPTGX	2D +8.21245308 E- 1		+1.12037738 E- 4	002444	32217	11037
SBRTGZ	2D +7.59909552 E- 3		+1.03670056 E- 6	002446	00174	20073
SAPTGZ	2D +1.45871904 E- 1		+1.99004586 E- 5	002450	04525	36707
BBR	1D -8.88576611 E+ 0B-8			002452	76706	
CBR	1D +3.94784176 E+ 1B-8			002453	04737	
BAP	1D -8.88576611 E+ 0B-8			002454	76706	
CAP	1D +3.94784176 E+ 1B-8			002455	04737	
VCOEBR	1D +3.05926514 E+ 1B-8			002456	03646	
ACOEBR	1D +2.37068853 E+ 1B-8			002457	02755	
VCOEAP	1D +3.05926514 E+ 1B-8			002460	03646	
ACOEAP	1D +2.37068853 E+ 1B-8			002461	02755	
JCOEBR	1D +1.38211192 E+ 1B-8			002462	02265	
SCOEBR	1D +1.59353531 E+ 1B-8			002463	01774	
JCOEAP	1D +1.38211192 E+ 1B-8			002464	02265	
SCOEAP	1D +1.59353531 E+ 1B-8			002465	01774	
FCDOWN	DEC 2236			002466	04274	
UPCRIT	1D +0.00000000 E+ 0B-10	UPCRIT	+0.00000000E+ 0	002467	00000	
DOWNCRIT	1D -3.04799999 E- 2B- 7	DOWNCRIT	-3.04799999E+ 0	002470	77773	
TENDBRAK	1D +1.62000000 E+ 4B-17	TENDBRAK	+1.62000000 E+ 2	003423	03751	
TENDAPPR	1D +2.20000000 E+ 3B-17	TENDAPPR	+2.20000000 E+ 1	003424	00423	
LOWCRIT	1D + 2272	FLO	+2.84908594 E+ 4	003426	04340	
HIGHCRIT	1D + 2347	FHI	+2.94249859 E+ 4	003425	04453	

Runs on AMELIA have disclosed several interesting facts:

(1) Forward redesignations of the landing site, for instance a 10000 foot downrange noun 69 input at the start of P64, can cause pulse-outs, as well as cause the LM to pitch forward from the vertical. Large backward redesignations also cause pulse outs, but this is not unexpected.

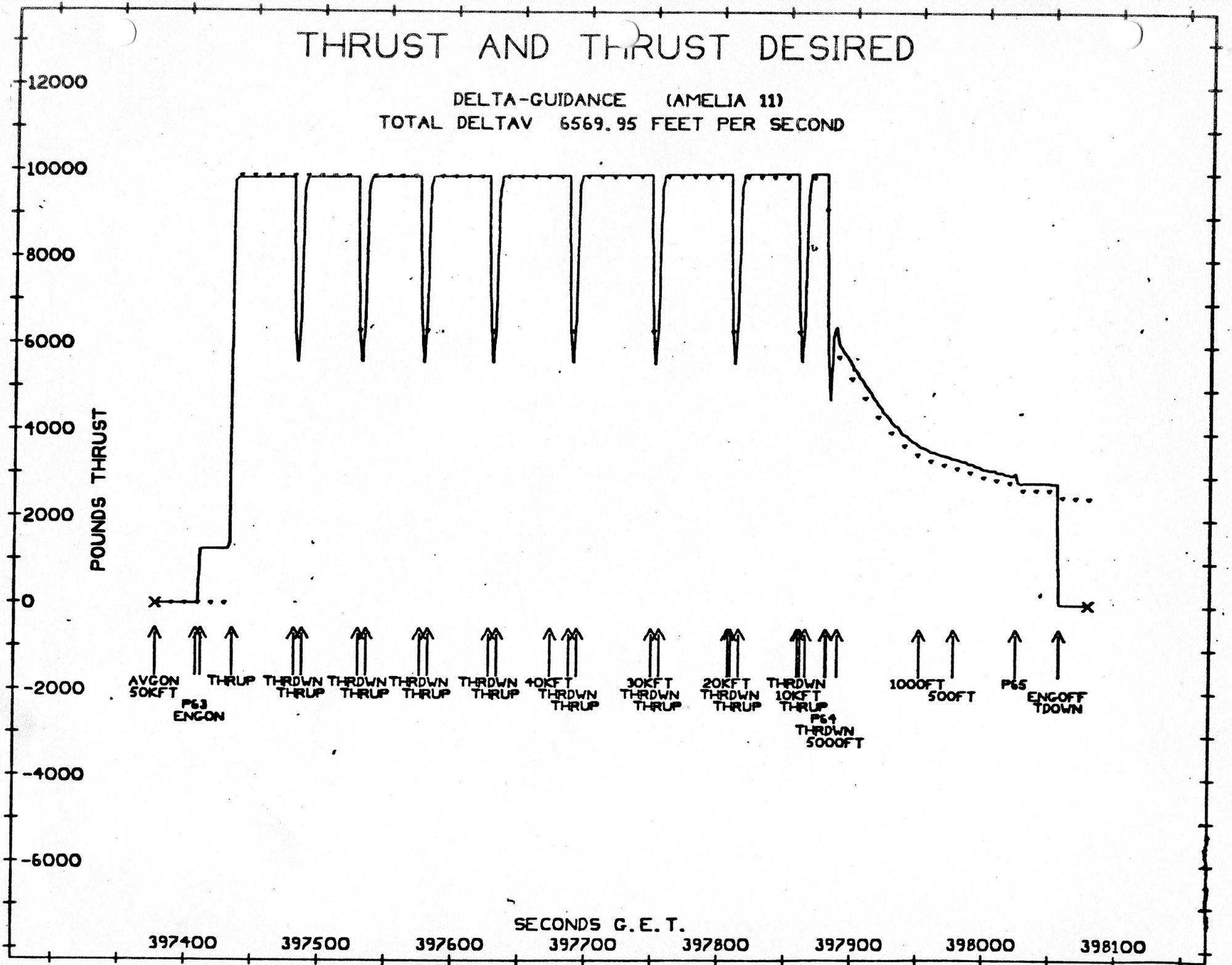
(2) A lateral velocity noise spike at TGO = -50 in P64 of 1.5 f/s after incorporation causes oscillations in roll. This is the problem cured for LUMINARY 1A by adding coefficients containing LEADTIME to the guidance equation (see Luminary Memo # 97). Maybe crafty choosing of A and B will clear this up, averting the necessity of putting back LEADTIME, which would be hard.

(3) It is confirmed that large downrange redesignations in P63 (via noun 69) cost no fuel - 50000 feet at the start of the burn was tried and actually less propellant was used.

Some plots are appended: first and second the thrust and pitch profiles of the nominal run for the interesting ways they differ from the old style, and third the roll (strictly CDUZ) in response to the lateral velocity noise spike.

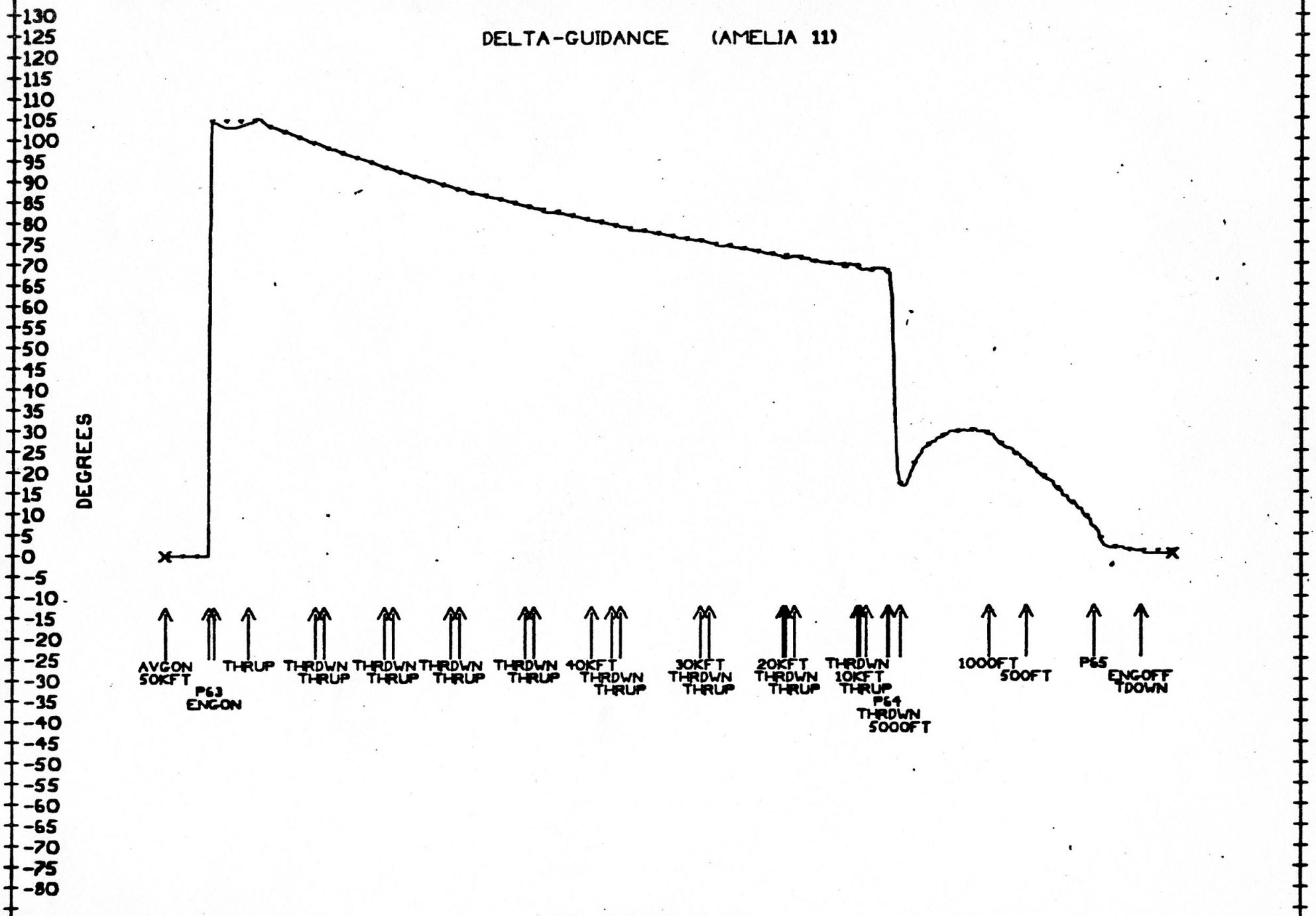
THRUST AND THRUST DESIRED

DELTA-GUIDANCE (AMELIA 11)
TOTAL DELTAV 6569.95 FEET PER SECOND



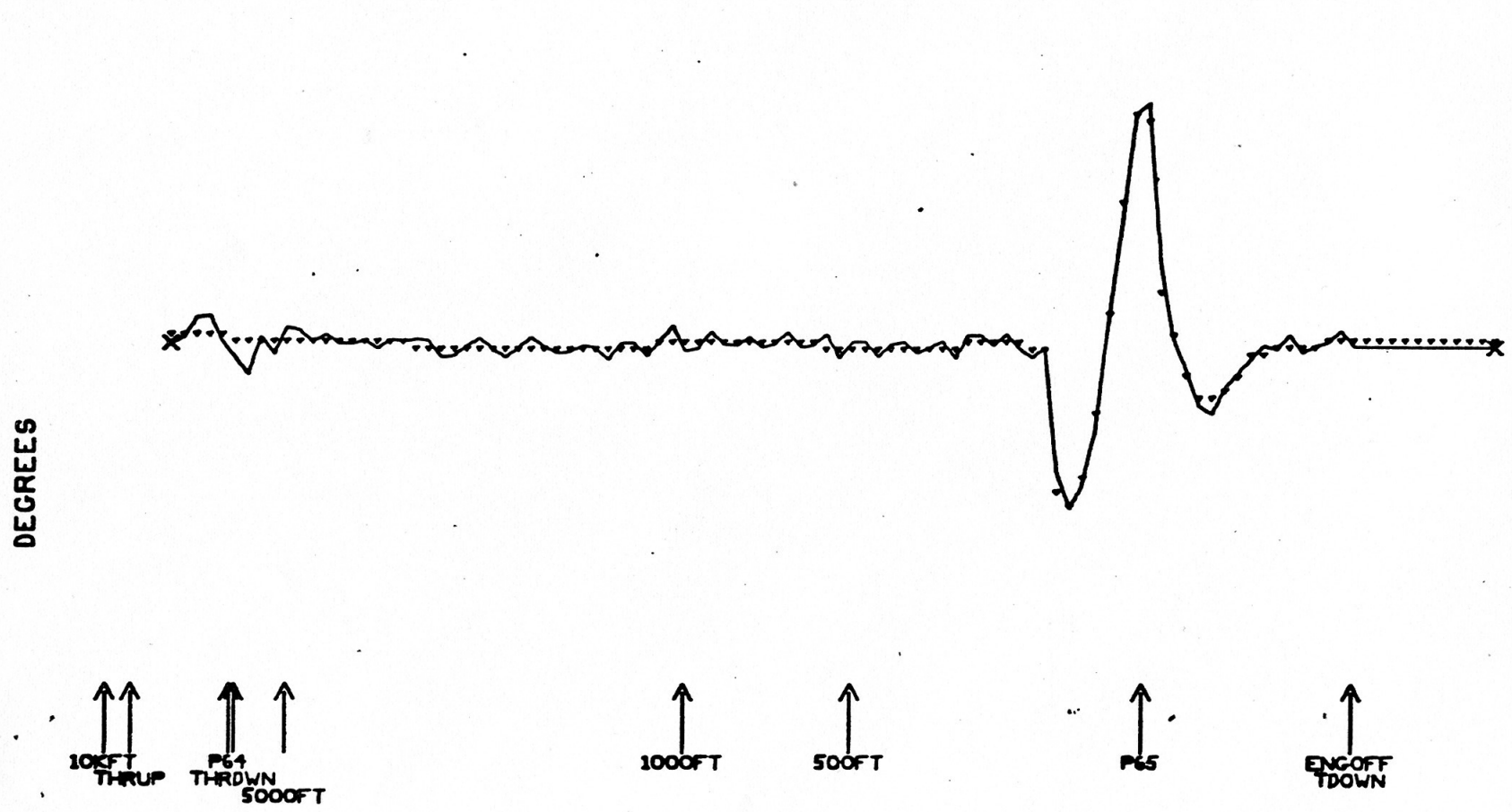
CDUY AND CDUYD

DELTA-GUIDANCE (AMELIA 11)



CDUZ AND CDUZD

DELTA-GUIDANCE (AMELIA 11) VELOCITY NOISE SPIKE AT TGO -50 IN P64



SECONDS G.E.T.

397850 397900 397950 398000 398050